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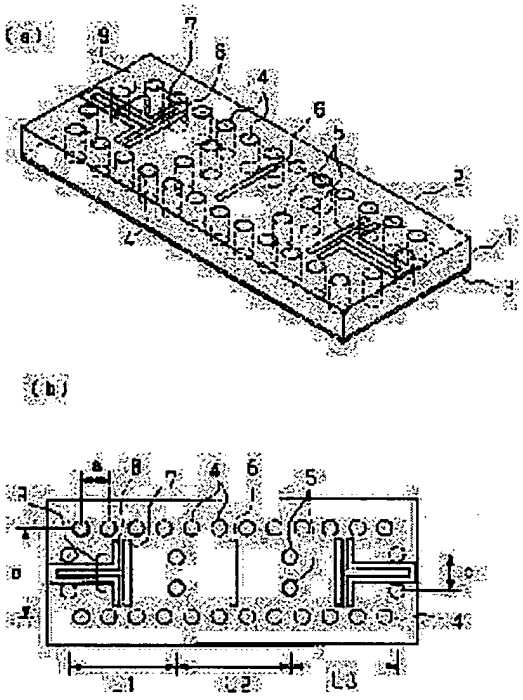
(54) FILTER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a small-sized dielectric waveguide filter having excellent filter characteristics even with a small number of stages and to provide a filter on which a waveguide-coplanar line conversion is directly formed and which can be connected to a plane circuit or flip-chip mounted.

SOLUTION: A front conductor 2 is formed to one side of a dielectric board 1 and a rear conductor 3 is formed onto the other side. Two lines of via-holes 4 interconnecting the front conductor 2 to the rear conductor 3 are formed in a signal transmission direction. A slit 6 formed by partially removing the conductor is formed on the front conductor 2 on the central resonator. The slit 6 is desirably formed at a right angle to the signal direction. Slits 7, 8 formed by partially eliminating the conductor are formed on the front conductor 2 on the resonators at both ends. A coplanar line 9 formed on the front conductor 2 is connected to the slit 8.



LEGAL STATUS

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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] A filter characterized by forming at least one or more slits in a long side conductor side of waveguide structure which constitutes said resonator in a filter with which at least one resonator was formed in rectangular waveguide structure where it filled up with a dielectric.
[Claim 2] A filter characterized by forming at least one or more slits in a long side conductor side of waveguide structure which constitutes said resonator in a filter with which a conductor side was formed in the upper surface and an inferior surface of tongue of a dielectric substrate, a conductor side was formed in said dielectric substrate side, and at least one resonator was formed in rectangular waveguide structure which makes a conductor side of said dielectric substrate a long side conductor side.
[Claim 3] a conductor side forms in the upper surface and an inferior surface of tongue of a dielectric substrate -- having -- the inside of said dielectric substrate -- a conductor -- a filter characterized by forming at least one or more slits in a long side conductor side of waveguide structure which constitutes said resonator in a filter with which a beer hall was formed and at least one resonator was formed in rectangular waveguide structure which makes a conductor side of said dielectric substrate a long side conductor side.
[Claim 4] A filter given in one claim of claims 1-3 characterized by forming at least one or more slits in a long side conductor side of waveguide structure which said odd resonators are arranged and constitutes a resonator of the center.
[Claim 5] A filter given in one claim of claims 1-4 characterized by forming a slit in sense which intersects perpendicularly with a long side conductor side of said waveguide structure in signal propagation.
[Claim 6] A filter given in one claim of claims 1-5 characterized by forming a KOPURENA track in a conductor side which constitutes said waveguide structure, forming at least one or more slits in a long side conductor side of said waveguide structure which constitutes said resonator, and connecting said KOPURENA track with said slit.
[Claim 7] A filter according to claim 6 characterized by connecting said KOPURENA track and the circuit board for mounting a filter through a bump.
[Claim 8] A filter given in one claim of claims 1-5 characterized by forming a slotted line way in a conductor side which constitutes said waveguide structure, forming at least one or more slits in a long side conductor side of waveguide structure which constitutes said resonator, and connecting said slotted line way with said slit.
[Claim 9] A filter according to claim 8 characterized by mounting said slotted line way and the circuit board for mounting a filter through a bump.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the filter which has the waveguide structure where it is used as RF components.
[0002]
[Description of the Prior Art] The typical waveguide filter used with microwave and a millimeter wave band is realized by using the resonator configuration in which drawing structure was formed, using a metal waveguide. Although this kind of filter is excellent in the engine performance, the technical problem that size is large occurs. Then, the false waveguide band pass mold filter with which the waveguide side by the metal beer hall was formed in the dielectric substrate is devised like a well-known example given in a Japanese-Patent-Application-No. No. 82184 [ten to] official report. As an example, the outline structure of a four-step configuration filter is shown in drawing 9 . Drawing 9 (a) is a perspective diagram and drawing 9 (b) is a plan. the whole surface of the dielectric substrate 1 -- the surface -- a conductor 2 -- the field of the opposite side -- a rear face -- the conductor 3 is formed. the surface -- a conductor 2 and a rear face -- two trains of beer halls 4 which connect a conductor 3 are formed in the direction of a signal transmission. As for the gap a of a beer hall, 1/2 or less [of the guide wave length] is respectively desirable. It can be considered that this structure is the false waveguide which makes the gap b of the beer hall on a par with the thickness of a dielectric, and two trains a waveguide cross section. In a waveguide, the pair of a beer hall 5 is formed further and the resonator made into the resonance length L1, L2, L3, and L4 is formed. By choosing appropriately the gap c of the beer hall 5 which serves as a pair here, frequency other than resonance frequency can be reflected effectively. On the other hand, with resonance frequency, a signal is passed and the desired filter engine performance is obtained. In this filter, it can consider as the magnitude of 1/rootepsilon about compared with the case where the interior of a waveguide is hollow (epsilon is the dielectric constant of a dielectric). On the other hand, the filter constituted using the microstrip line on a dielectric substrate is often used. It is comparatively small, and since it is connectable with a plane circuit and wirebonding, such as an integrated circuit, it can mount easily in a RF module.
[0003]
[Problem(s) to be Solved by the Invention] However, a miniaturization may be required in a waveguide filter. For example, it is 5mm angle degree which has the large size of the microwave and millimeter wave integrated circuit formed on a semiconductor. Therefore, in constituting a small multi chip module using an integrated circuit, it becomes important to reduce the size of a passive component like a filter. Moreover, generally connection with a plane circuit is difficult. Then, a filter with the function which can be mounted and connected easily is desired, without adding a special conversion circuit, without enlarging size. On the other hand, with the filter using a microstrip line, when mounted in package structure, change may appear in the engine performance. Since electromagnetic-field distribution has spread to the upper part, this originates in it being easy to be influenced by wearing of a lid in a microstrip line. Moreover, in connection by wirebonding, it is a RF like especially a millimeter wave band, and the engine-performance change by dispersion in the parasitism inductor component decided by wire length or wire length cannot be disregarded. For this reason, it is the factor of the yield fall at the time of mass production. In order to solve this problem, development of the flip chip mounting technology which mounts and connects a millimeter wave semiconductor integrated circuit with a mounting substrate by the bump by face down is furthered. This technology is indicated by well-known reference (K.Maruhashi et al., IEEE International Solid-State Circuits Symposium, Digest, pp.324-325, 2000), for example. Since between each element and mounting substrates is connected in a comparatively short distance (200 micrometers or less) when flip chip mounting is applied, the effect of the parasitism inductance component which poses a problem by wirebonding, and its dispersion can be disregarded. When it was going to apply flip chip mounting technology similarly

to a filter, it had the terminal suitable for the KOPURENA track used for connection between elements, and even if further mounted by the face down, implementation of the filter which has structure with little change of the filter engine performance was desired strongly.
[0004] This invention was made in consideration of such a situation, and the purpose is in offering the filter in which flip chip mounting is possible, without preparing the special external terminal for connection with a plane circuit, while offering the filter of the small dielectric-waveguide mold structure of having the filter shape excellent also in the small number of stages.
[0005]
[Means for Solving the Problem] In order to solve the above problem, invention according to claim 1 is a filter characterized by forming at least one or more slits in a long side conductor side of waveguide structure which constitutes a resonator in a filter with which at least one resonator was formed in rectangular waveguide structure where it filled up with a dielectric. Invention according to claim 2 is a filter characterized by forming at least one or more slits in a long side conductor side of waveguide structure which constitutes a resonator in a filter with which a conductor side was formed in the upper surface and an inferior surface of tongue of a dielectric substrate, a conductor side was formed in the dielectric substrate side, and at least one resonator was formed in rectangular waveguide structure which makes a conductor side of a dielectric substrate a long side conductor side. a conductor side forms invention according to claim 3 in the upper surface and an inferior surface of tongue of a dielectric substrate -- having -- the inside of a dielectric substrate -- a conductor -- in a filter with which a beer hall was formed and at least one resonator was formed in rectangular waveguide structure which makes a conductor side of a dielectric substrate a long side conductor side, it is the filter characterized by to form at least one or more slits in a long side conductor side of waveguide structure which constitutes a resonator. In invention given in one claim of claims 1-3, odd resonators are arranged and invention according to claim 4 is characterized by forming at least one or more slits in a long side conductor side of waveguide structure which constitutes a resonator of the center. Invention according to claim 5 is characterized by forming a slit at sense which intersects perpendicularly with a long side conductor side of waveguide structure in signal propagation in invention given in one claim of claims 1-4. A KOPURENA track is formed in a conductor side which constitutes waveguide structure in invention given in one claim of claims 1-5, at least one or more slits are formed in a long side conductor side of waveguide structure which constitutes a resonator, and invention according to claim 6 is characterized by connecting a KOPURENA track with a slit. Invention according to claim 7 is characterized by connecting a KOPURENA track and the circuit board for mounting a filter through a bump in invention according to claim 6. A slotted line way is formed in a conductor side which constitutes waveguide structure in invention given in one claim of claims 1-5, at least one or more slits are formed in a long side conductor side of waveguide structure which constitutes a resonator, and invention according to claim 8 is characterized by connecting a slotted line way with a slit. Invention according to claim 9 is characterized by mounting the circuit board for mounting a slotted line way and a filter through a bump in invention according to claim 8.
[0006]
[Embodiment of the Invention] Drawing 2 is filter outline structural drawing in this invention having shown the gestalt of the 1st operation. Drawing 2 (a) is a perspective diagram and drawing 2 (b) is a plan. the whole surface of the dielectric substrate 1 -- the surface -- a conductor 2 -- the field of the opposite side -- a rear face -- the conductor 3 is formed. the surface -- a conductor 2 and a rear face -- two trains of beer halls 4 which connect a conductor 3 are formed in the direction of a signal transmission. As for the gap a of a beer hall, 1/2 or less [of the guide wave length] is respectively desirable. It can be considered that this structure is the false waveguide which makes the thickness (the direction of a shorter side) of a dielectric, and the gap b of the beer hall on a par with two trains (the direction of a long side) a waveguide cross section. In a waveguide, the pair of a beer hall 5 is formed further and the resonator which sets resonance length to L1, L2, and L3 is formed. Frequency other than resonance frequency can be reflected by choosing appropriately the gap c of the beer hall 5 which serves as a pair here. On the other hand, with resonance frequency, a signal is passed and the desired filter engine performance is obtained.
[0007] the three-step configuration which, as for this filter, a resonator becomes from three pieces -- it is -- the surface of the central resonator upper part -- the slit 6 from which the conductor was removed partially is formed in the conductor 2. As for a slit 6, it is desirable to make it arrange at a right angle in the direction of a signal. The filter shape (insertion loss) in the gestalt of this operation is shown in drawing 3 . In addition, although the filter of the four-step configuration shown in drawing 4 from which 3dB passband becomes almost the same as an example of a property of a filter conventionally, and drawing did not show, frequency dependent [of the insertion loss about the filter of the same three step configuration] was shown in coincidence. For example, when 6GHz is left to a low-pass side to the center frequency of 61GHz (55GHz), the insertion loss of this example is 40dB. This value is larger than 25dB of insertion

losses of the filter of the three-step configuration by the conventional example, and almost the same as the value of 42dB of the filter of a four-step configuration. Therefore, according to the gestalt of this operation, even if it uses the configuration of a small number of stages compared with the former, the amount of oppression of a good unnecessary frequency band signal is obtained. Therefore, the miniaturization of a filter can be attained and low-pricing of the filter itself or the miniaturization of the RF circuit module using a filter is realized.

[0008] An attenuation pole is formed in a low-pass side of installation of this slit 6, and the principle of operation of the gestalt of operation of this invention is to raise the amount of oppression of an unnecessary frequency band signal. Although the attenuation pole was formed in the low-pass side with the gestalt of this operation, it is also possible by adjusting slit length to form an attenuation pole in a high region side. When a slit is prepared on the resonator of the center of a filter with odd resonators, it is found out by changing slit length that the frequency in which an attenuation pole appears can be adjusted easily, without changing other structure parameters. Moreover, since a slit can pass along between beer halls 4 if needed and the length can also be made to increase to the outside of the waveguide structured division, layout flexibility is high. An attenuation pole can also be established in both by the side of a high region and low-pass by forming the slit from which length differs on further two or more resonators.

[0009] In addition, although the signal electromagnetic field from the interior of a false waveguide are revealed from a slit, since a dielectric exists in the interior of a false waveguide, the effect is small. Even if it follows, for example, it includes in a module and it equips with a lid, the effect on a filter shape is small. The filter in the gestalt of this operation is easily producible with the alumina ceramic substrate process known well. That is, it results in the completion of production through production processes, such as beer hall formation, restoration of a metal paste, baking, thin film wiring formation (slit formation), and gold plate, using a ceramic material sheet. However, in this invention, a substrate material, the formation method of a beer hall, and the slit formation method are not limited. Moreover, although two trains of beer halls 4 are formed in the direction of a signal transmission, as long as it forms false waveguide structure, the number of trains may be how much.

[0010] Drawing 4 is filter outline structural drawing in this invention having shown the gestalt of the 2nd operation. Drawing 4 (a) is a perspective diagram and drawing 4 (b) is a plan. the whole surface of the dielectric substrate 1 -- the surface -- a conductor 2 -- the field of the opposite side -- a rear face -- the conductor 3 is formed. the surface -- a conductor 2 and a rear face -- two trains of beer halls 4 which connect a conductor 3 are formed in the direction of a signal transmission. As for the gap a of a beer hall, 1/2 or less [of the guide wave length] is respectively desirable. It can be considered that this structure is the false waveguide which makes the gap b of the beer hall on a par with the thickness of a dielectric, and two trains a waveguide cross section. In a waveguide, the pair of a beer hall 5 is formed further and the resonator which resonance length sets to L1, L2, L3, and L4 is formed. Frequency other than resonance frequency can be reflected by choosing appropriately the gap c of the beer hall 5 which serves as a pair here. On the other hand, with resonance frequency, a signal is passed and the desired filter engine performance is obtained. the four-step configuration which, as for this filter, a resonator becomes from four pieces -- it is -- the surface of the resonator upper part of both ends -- the slits 7 and 8 from which the conductor was removed partially are formed in the conductor 2. a slit 8 -- the surface of the resonator upper part -- the KOPURENA track 9 formed in the conductor 2 is connected.

[0011] According to the gestalt of operation of the 2nd of this invention, the KOPURENA track 9 formed on the resonator serves as a terminal for external connection as it is. Therefore, compared with the conventional example (drawing 9) which needs another connection in the direction of a signal, it is producible small. Moreover, it is not necessary to prepare a special transducer independently, and can connect by methods, such as a plane circuit and wirebonding. In addition, although the signal electromagnetic field from the interior of a false waveguide are revealed from a slit, since a dielectric exists in the interior of a false waveguide, the effect is small. Even if it follows, for example, it includes in a module and it equips with a lid, the effect on a filter shape is small.

[0012] One example of the mounting method of the filter by the gestalt of this operation is shown in drawing 5 . The KOPURENA track 13 is formed in the mounting substrate 11 in which the filter 10 by the gestalt of this operation should be mounted using the conductor pattern 12. For example, the bump 14 who uses gold as a component is formed on the mounting substrate 11. By methods of construction, such as thermocompression bonding, a filter minds a bump, and is mounted and connected with the mounting substrate 11. An integrated circuit etc. may be mounted in this mounting substrate besides a filter. In this invention, bump's class and the forming method are not limited, and even if it uses a solder bump or forms a bump in a filter side, it is inoffensive. Although a mounting substrate affects leakage electromagnetic field from a slit by this mounting method, since a dielectric exists in the interior of a false waveguide, the effect is comparatively small. In order to reduce this effect furthermore, methods, such as establishing a crevice in the field to which the filter on the mounting substrate 11 should be mounted, are also possible like another example of mounting shown in drawing 6 . As mentioned above, in the filter in the gestalt of operation of this invention, engine-

performance change before and after mounting can be suppressed, and the advantage of the parasitism inductance component which poses a problem by wirebonding, and flip chip mounting that the effect of the dispersion can be disregarded can be enjoyed.

[0013] Drawing 7 is filter outline structural drawing in this invention having shown the gestalt of the 3rd operation. Drawing 7 (a) is a perspective diagram and drawing 7 (b) is a plan. although main structures are the same as the filter shown in drawing 4 in this filter -- a slit 8 -- the surface of the resonator upper part -- the slotted line way 16 formed in the conductor 2 is connected. One example of the mounting method of the filter by the gestalt of this operation is shown in drawing 8 . The KOPURENA track 13 is formed in the mounting substrate 11 in which the filter 10 by this example should be mounted using the conductor pattern 12. The slotted line way-KOPURENA track transducer 18 is formed at the tip of a KOPURENA track. The bump 14 who uses gold as a component further, for example is formed on the mounting substrate 11. A filter is mounted with the mounting substrate 11 through a bump by methods of construction, such as thermocompression bonding. At this time, the slotted line way formed in the filter is connected with the KOPURENA track on a mounting substrate by electromagnetic-field association through the slotted line way-KOPURENA track transducer 18. Consequently, like the gestalt of the 2nd operation, engine-performance change before and after mounting can be suppressed, and the parasitism inductance component which poses a problem by wirebonding, and the advantage of flip chip mounting that the effect of that dispersion can be disregarded can be enjoyed.

[0014] Drawing 1 is filter outline structural drawing in this invention having shown the gestalt of the 4th operation, and expresses the feature of this invention best. Drawing 1 (a) is a perspective diagram and drawing 1 (b) is a plan. the whole surface of the dielectric substrate 1 -- the surface -- a conductor 2 -- the field of the opposite side -- a rear face -- the conductor 3 is formed. the surface -- a conductor 2 and a rear face -- two trains of beer halls 4 which connect a conductor 3 are formed in the direction of a signal transmission. As for the gap a of a beer hall, 1/2 or less [of the guide wave length] is respectively desirable. It can be considered that this structure is the false waveguide which makes the gap b of the beer hall on a par with the thickness of a dielectric, and two trains a waveguide cross section. In a waveguide, the pair of a beer hall 5 is formed further and the resonator which sets resonance length to L1, L2, and L3 is formed. Frequency other than resonance frequency can be reflected by choosing appropriately the gap c of the beer hall 5 which serves as a pair here. On the other hand, with resonance frequency, a signal is passed and the desired filter engine performance is obtained. the three-step configuration which, as for this filter, a resonator becomes from three pieces -- it is -- the surface of the central resonator upper part -- the slit 6 from which the conductor was removed partially is formed in the conductor 2. As for a slit 6, it is desirable to make it arrange at a right angle in the direction of a signal. the surface of the resonator upper part of both ends -- the slits 7 and 8 from which the conductor was removed partially are formed in the conductor 2. a slit 8 -- the surface -- the KOPURENA track 9 formed in the conductor 2 is connected. According to this example, it is possible to attain miniaturization of a filter and low-pricing, and flip chip mounting technology etc. becomes applicable as indicated by explanation of the 1st and 2nd examples.

[0015]

[Effect of the Invention] As explained above, in invention according to claim 1, a resonator is formed in the rectangular waveguide with which it filled up with the dielectric, the attenuation pole which improves a signal oppression out of band by forming a slit in the long side conductor side of the waveguide structure which constitutes a resonator is built, and the unnecessary frequency band signal of a filter can be controlled. Thereby, since the number of stages of a filter can be reduced, the miniaturization of a filter can be attained and easy-izing of manufacture and low-pricing can be realized. Furthermore, since the slit is formed in the waveguide structure where it filled up with the dielectric, when are mounted in a RF module, and electromagnetic field mainly exist in a dielectric, there is little leakage from a slit and it can make effect on a filter shape small. In the filter with which the conductor side was formed in the upper surface and the inferior surface of tongue of a dielectric substrate, the conductor side was formed in the dielectric substrate side in invention according to claim 2, and the resonator was formed in the rectangular waveguide structure which makes the conductor side of a dielectric substrate a long side conductor side By forming a slit in the long side conductor side of the waveguide structure which constitutes a resonator, the attenuation pole which improves a signal oppression out of band is built, and the unnecessary frequency band signal of a filter can be controlled. Thereby, like the case of claim 1, the miniaturization of a filter, easy-izing of manufacture, and low-pricing are realizable, and when mounted in a RF module, effect on a filter shape can be made small. In the filter with which the beer hall was formed and the resonator was formed in the rectangular waveguide structure which makes the conductor side of a dielectric substrate a long side conductor side a conductor side forms in the upper surface and the inferior surface of tongue of a dielectric substrate in invention according to claim 3 -- having -- the inside of a dielectric substrate -- a conductor -- By forming a slit in the long side conductor side of the waveguide structure which constitutes a resonator, the attenuation pole which improves a

signal oppression out of band is built, and the unnecessary frequency band signal of a filter can be controlled. Thereby, like the case of claim 1 and claim 2, the miniaturization of a filter, easy-izing of manufacture, and low-pricing are realizable, and when mounted in a RF module, effect on a filter shape can be made small. In invention according to claim 4, by arranging odd resonators and forming a slit in the long side conductor side of the waveguide structure which constitutes the resonator of the center, adjustment of an attenuation pole is attained without spoiling a filter shape with symmetric property, and the filter which can adjust easily the frequency in which an attenuation pole appears can be offered. In invention according to claim 5, it becomes possible to realize efficiently adjustment of the frequency in which an attenuation pole appears by forming a slit in the sense which intersects perpendicularly with the long side conductor side of waveguide structure in signal propagation. In invention according to claim 6, a KOPURENA track is formed in the conductor side which constitutes waveguide structure, a slit is formed in the long side conductor side of the waveguide structure which constitutes a resonator, and it becomes connectable with a plane circuit, without [without it prepares an external terminal specially by connecting the KOPURENA track with the slit, and] carrying out long leading about for connection with a terminal, and a filter can be formed small. In invention according to claim 7, by connecting the KOPURENA track on a filter, and the circuit board in which a filter is mounted through a bump, flip chip mounting can be performed easily and reduction of a man day and good connection of the repeatability in a RF are attained. In invention according to claim 8, a slotted line way is formed in the conductor side which constitutes waveguide structure, a slit is formed in the long side conductor side of the waveguide structure which constitutes a resonator, and it becomes connectable with a plane circuit, without [without it prepares an external terminal specially by connecting the slotted line way with the slit, and] carrying out long leading about for connection with a terminal, and a filter can be formed small. In invention according to claim 9, by connecting the slotted line way on a filter, and the circuit board in which a filter is mounted through a bump, flip chip mounting can be performed easily and reduction of a man day and good connection of the repeatability in a RF are attained.

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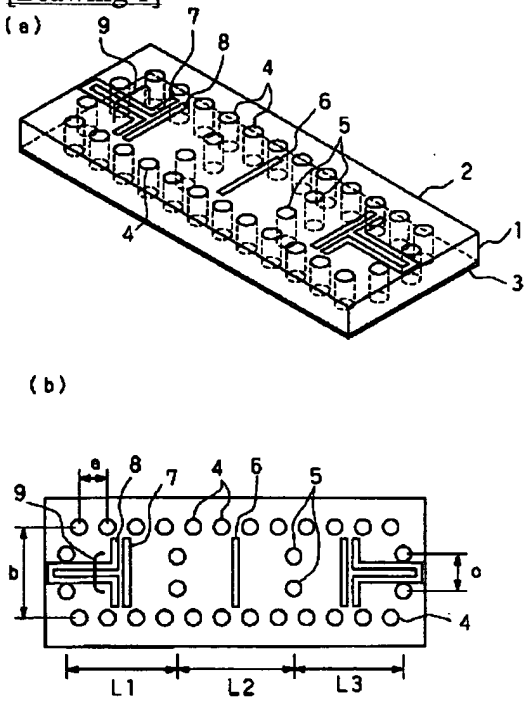
DRAWINGS

[Drawing 1]



[Drawing 2]

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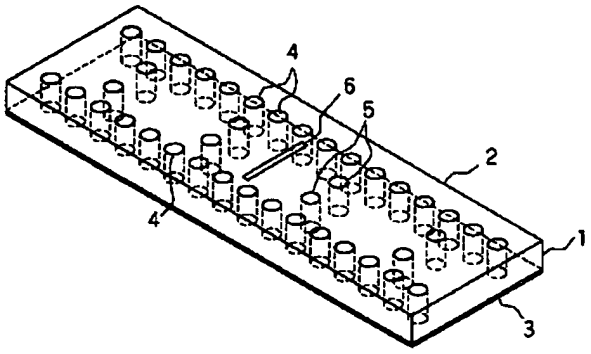

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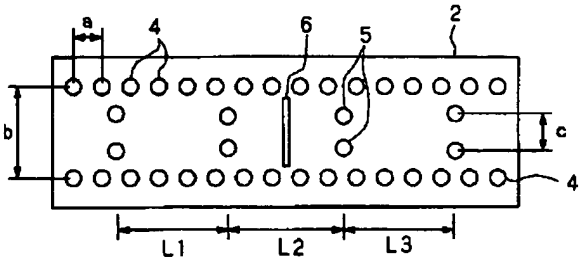

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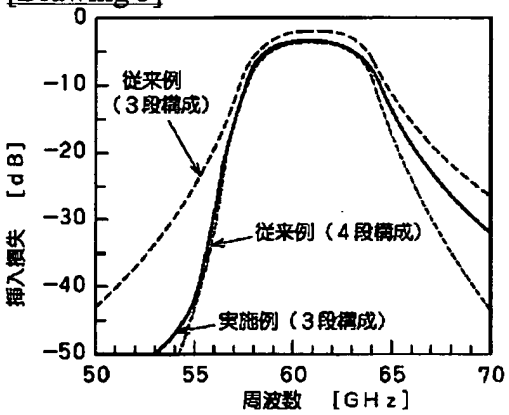

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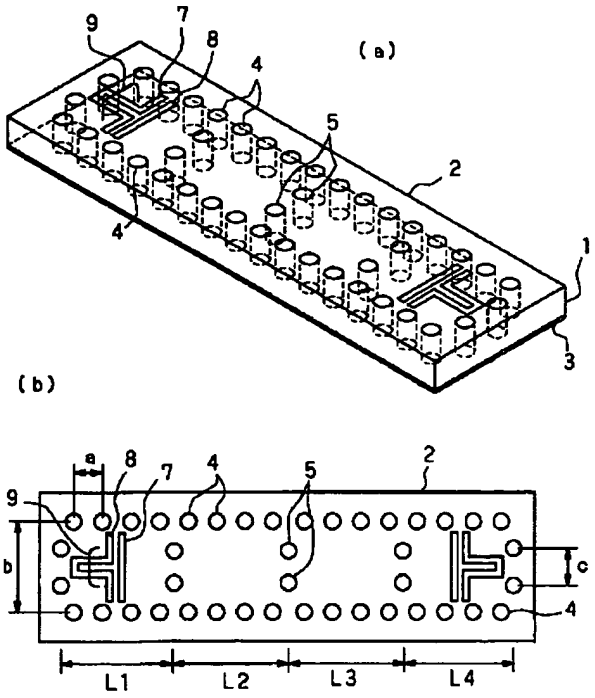

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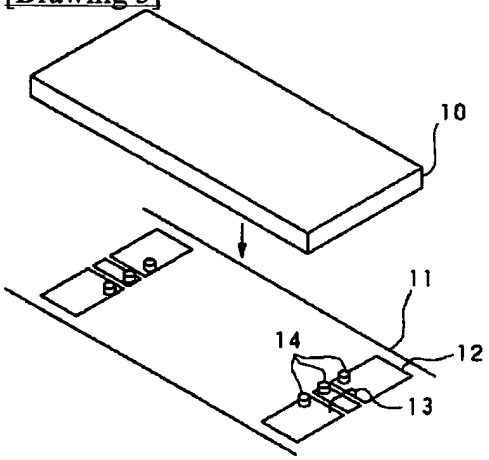

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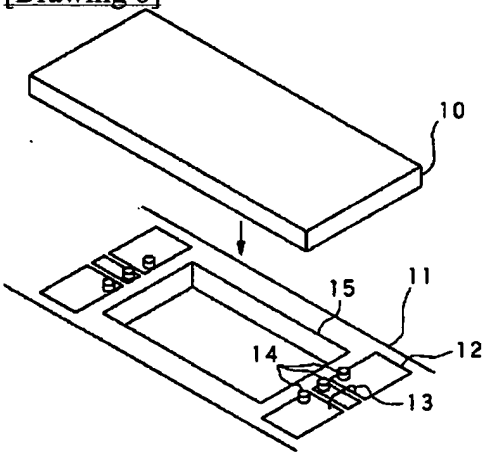

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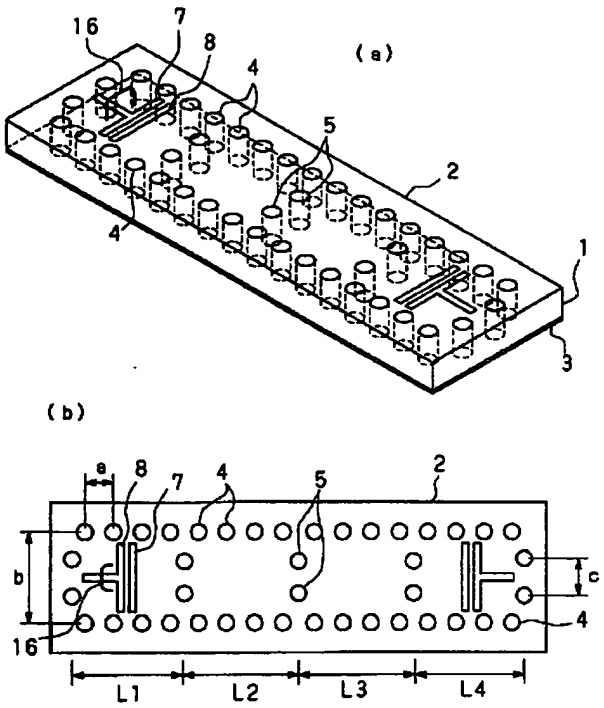

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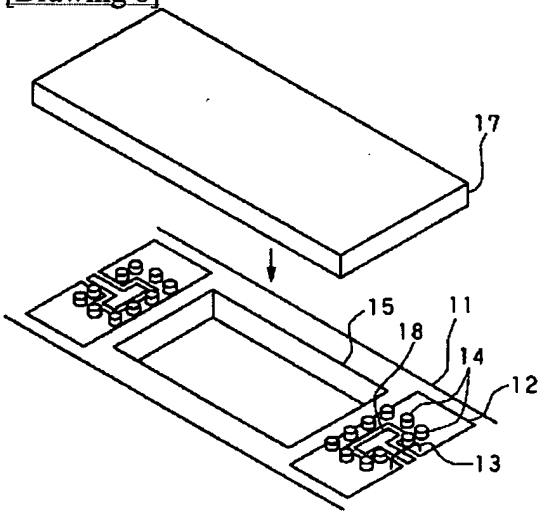
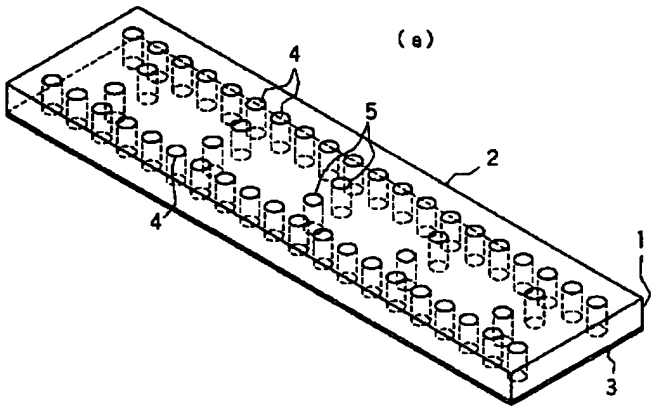
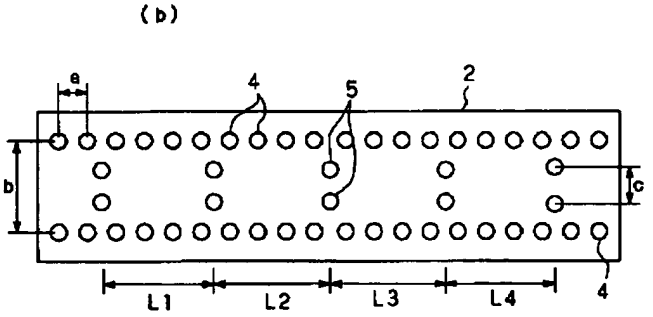


[Drawing 9]





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